

# **The GLOBE Contrail Protocol: A Student- Scientist Partnership**

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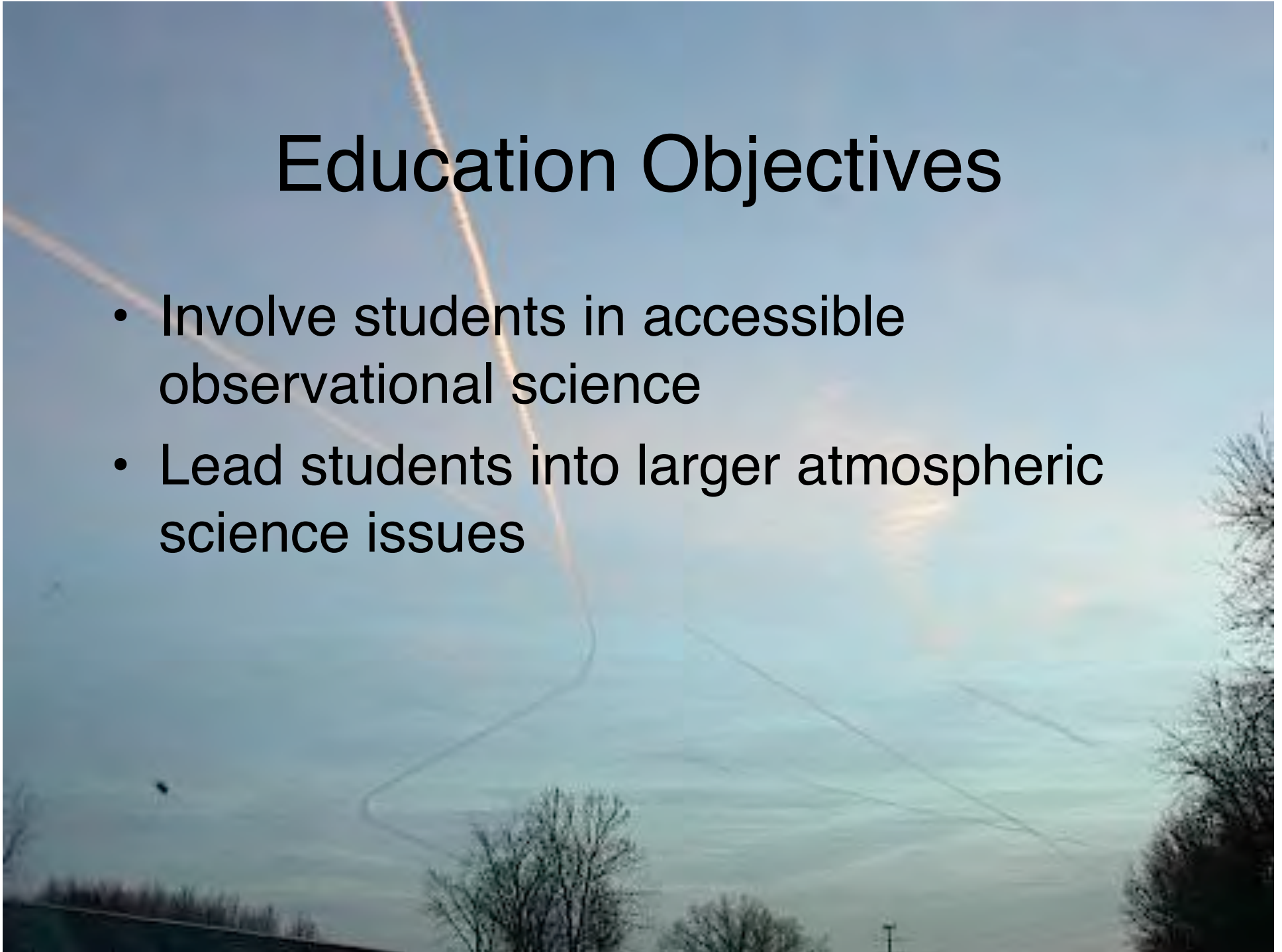


# Science Objectives

- Obtain contrail and other cloud information from the largest possible network of ground observers
- Use to:
  - Validate satellite retrieval algorithms
  - Improve contrail prediction methods

# Education Objectives

- Involve students in accessible observational science
- Lead students into larger atmospheric science issues



# Outline

- What are contrails?
- Why is NASA involved?
- Why and how are students important to this study?



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# What are Contrails?

- Contrails are **CLOUDS** that form in the wake of aircraft.
- Contrail is a shortened name for condensation trails.
- Also known as vapor trails, jet trails, “chemtrails”



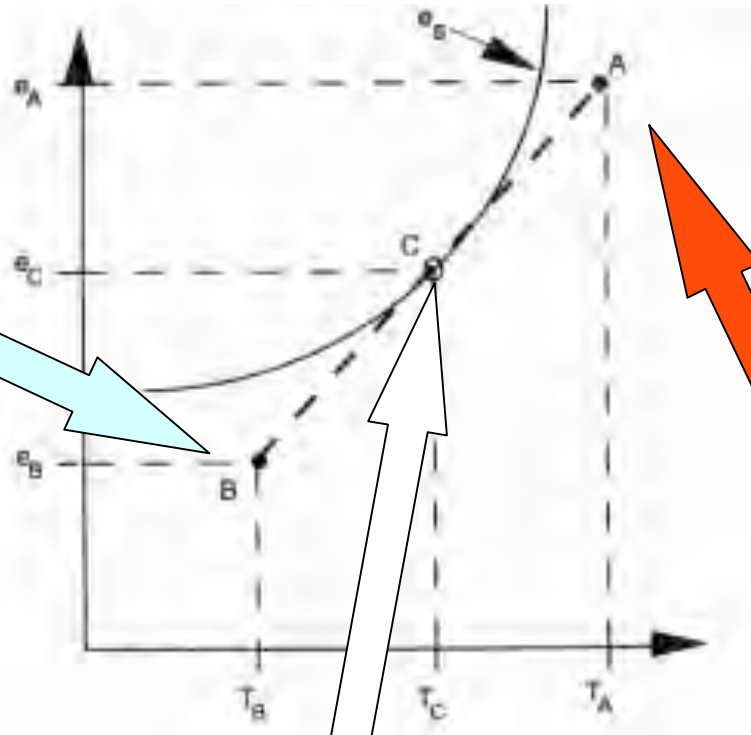
# Contrails have been around for a long time!



- They were first described in the scientific literature in 1919.
- During WWII, contrails sometimes littered the skies during aerial combat.

# What is a Mixing Cloud?

B. Cold, dry air in upper atmosphere



A. Hot, moist air from plane exhaust

C. If you cross the line ...  
contrail!

The cloud that forms  
on your breath during  
a cold day is a mixing  
cloud



# Do Contrails Affect Cloud Cover?



# Outline

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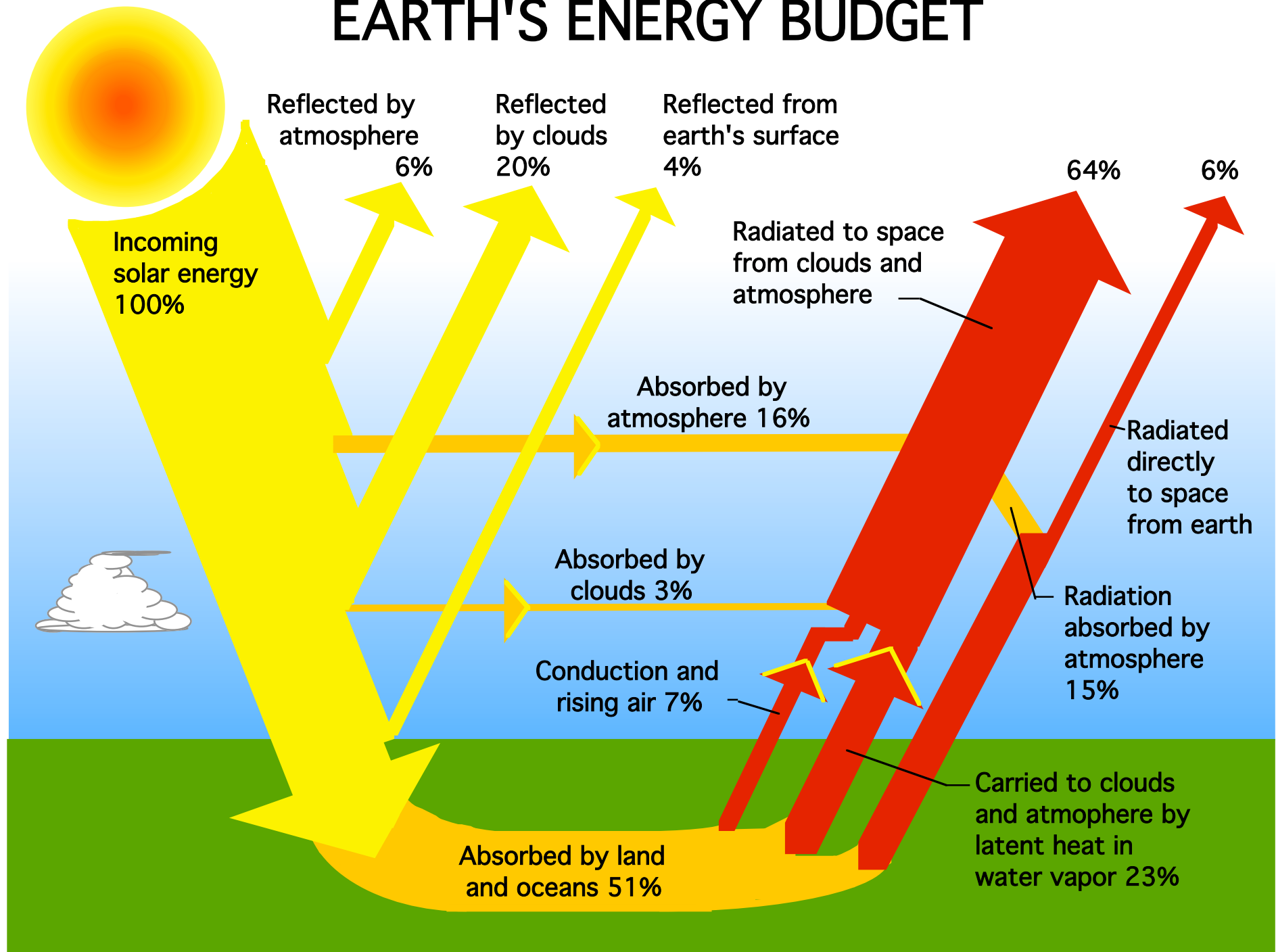


# Global Cloud Cover

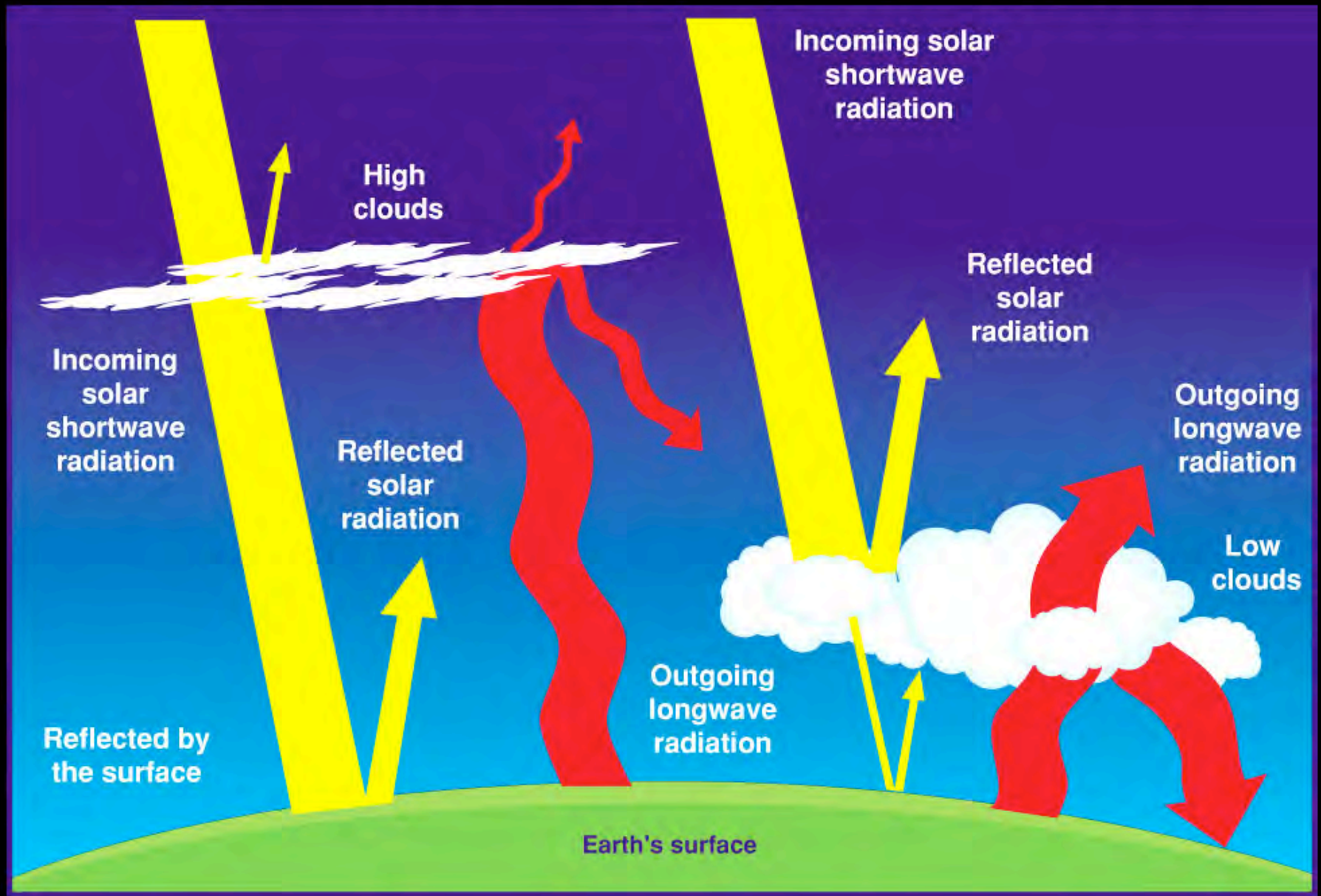
August 26, 1993



# EARTH'S ENERGY BUDGET



# Cloud Effects On Earth's Radiation



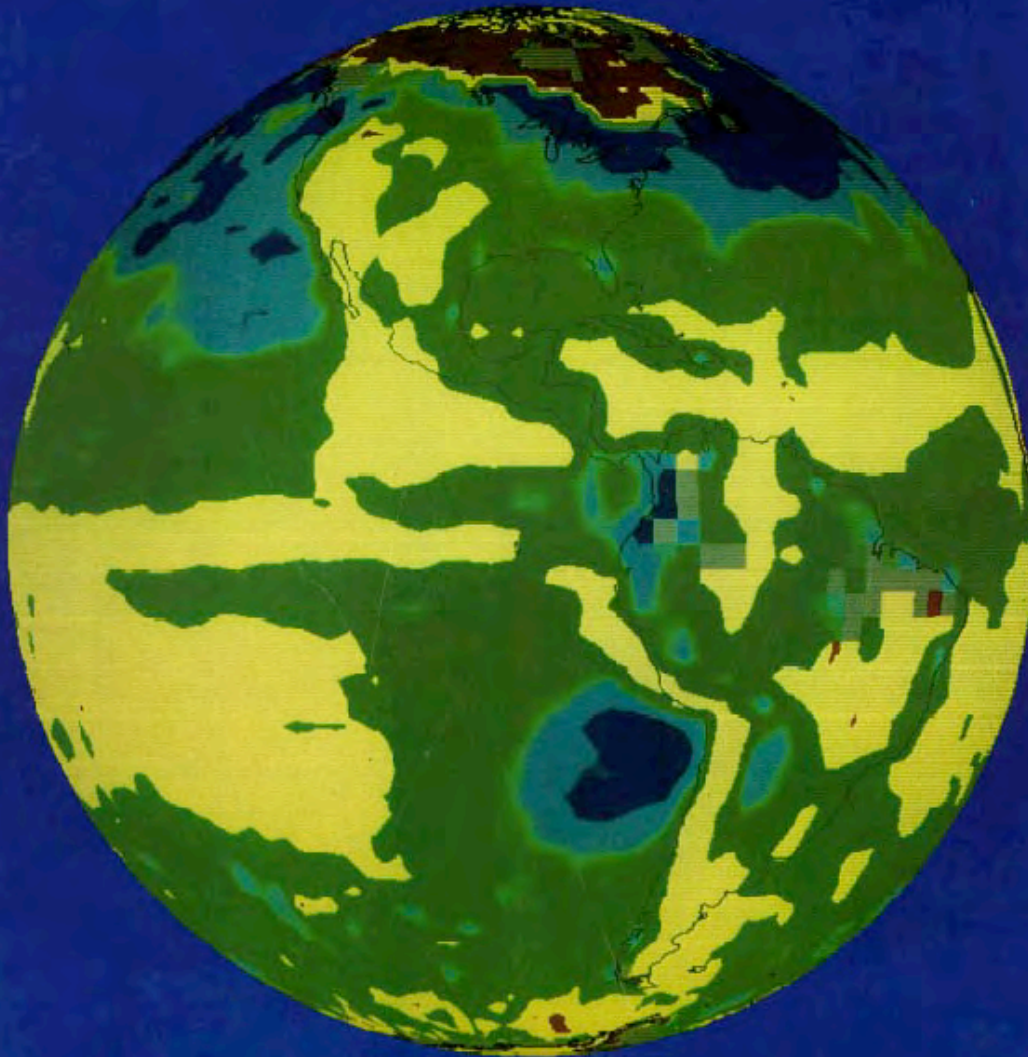


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**Derived Product**

**Requires Cloud  
Detection and  
Cloud Property  
Retrieval**

# Why Do We Study Contrails?



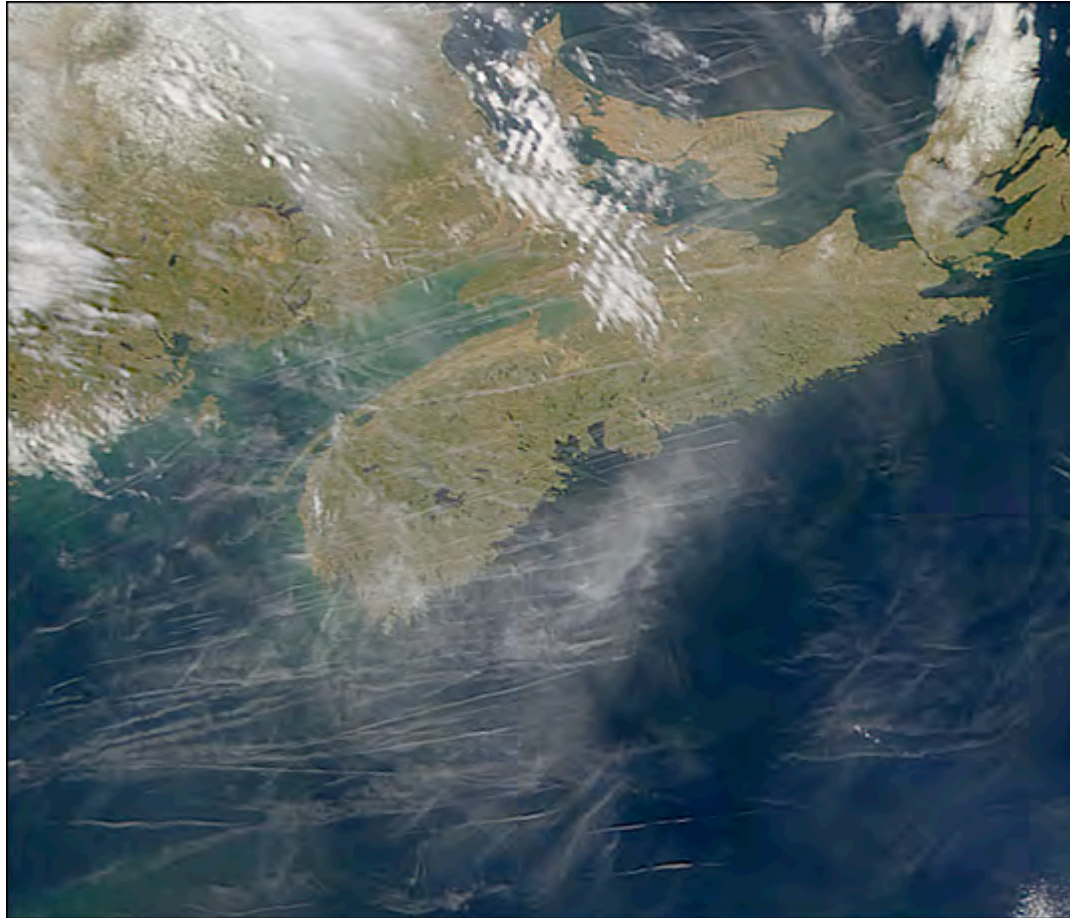
When the upper atmosphere is moist enough, the contrails continue to grow.



Under these conditions, the contrails become *persistent*.

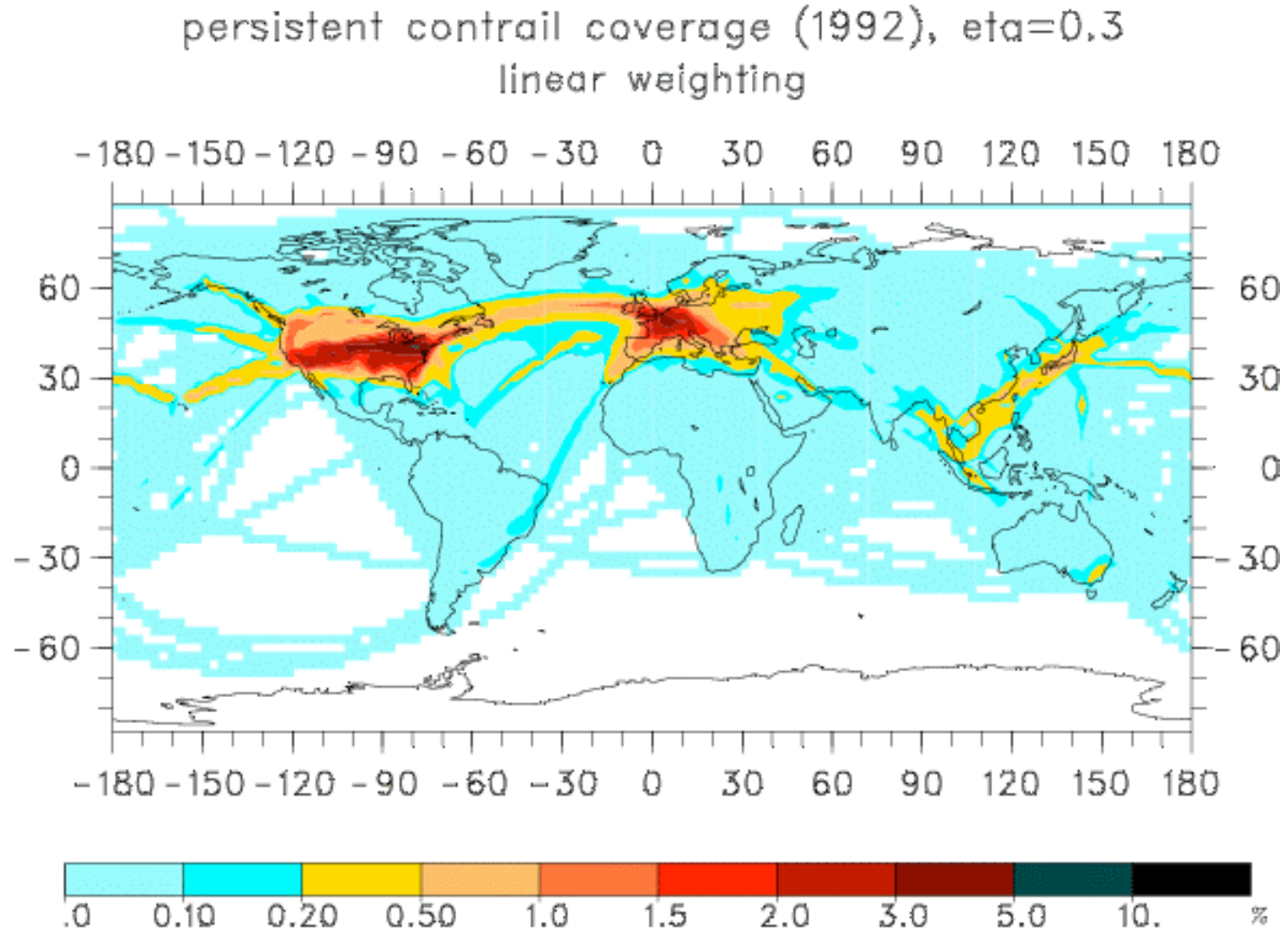
Persistent  
contrails  
occasionally  
cover large  
areas.

Like cirrus  
clouds,  
contrails  
likely  
contribute to  
global  
warming.

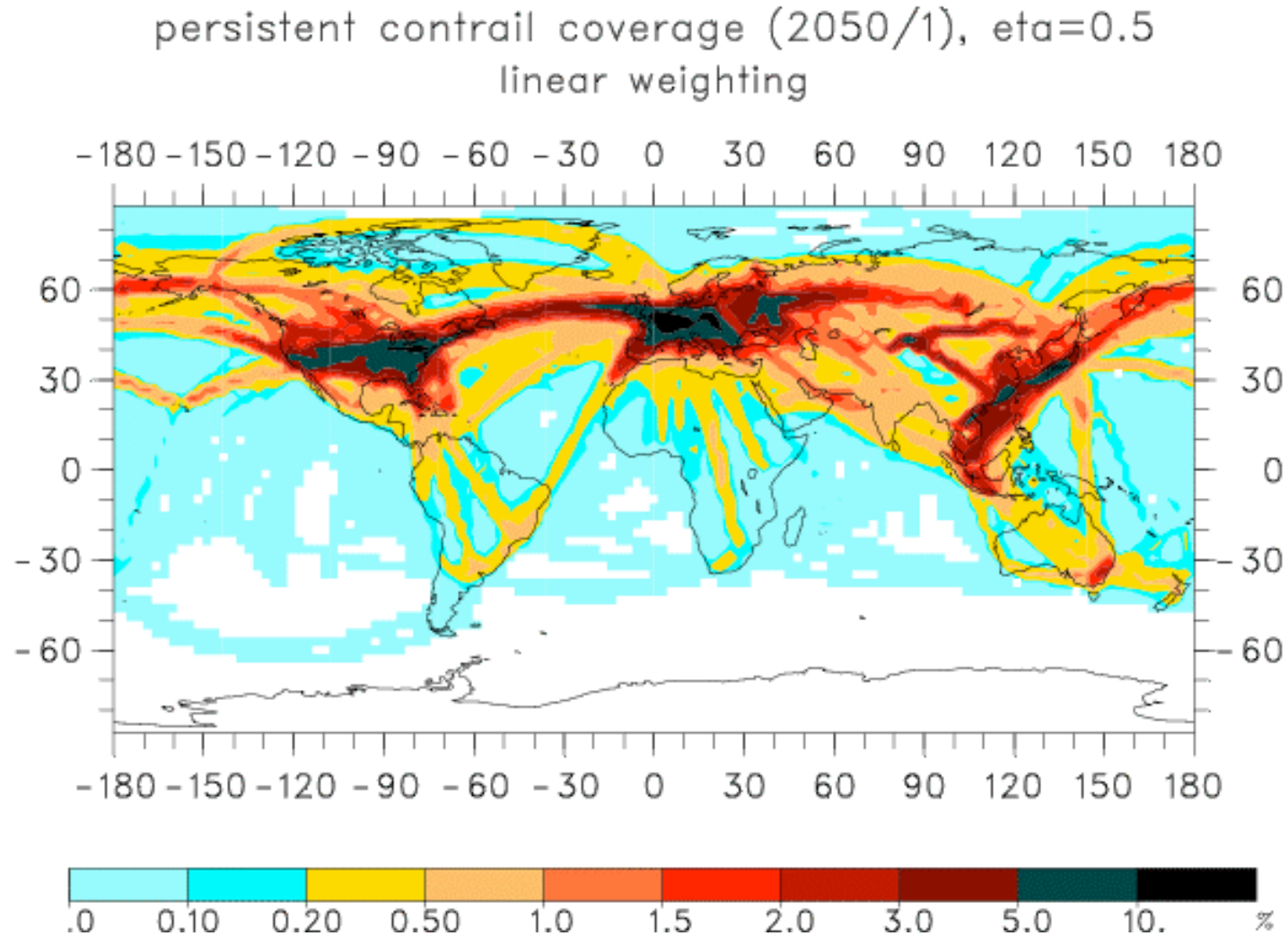


We currently  
estimate that  
contrails add  
an additional  
0.5 to 5 %  
warming to  
the  
greenhouse  
gas effect.





Air traffic and persistent contrail coverage will continue to increase.



By 2050, warming due to contrails may be 2.5 to 25 % of the current greenhouse gas warming.



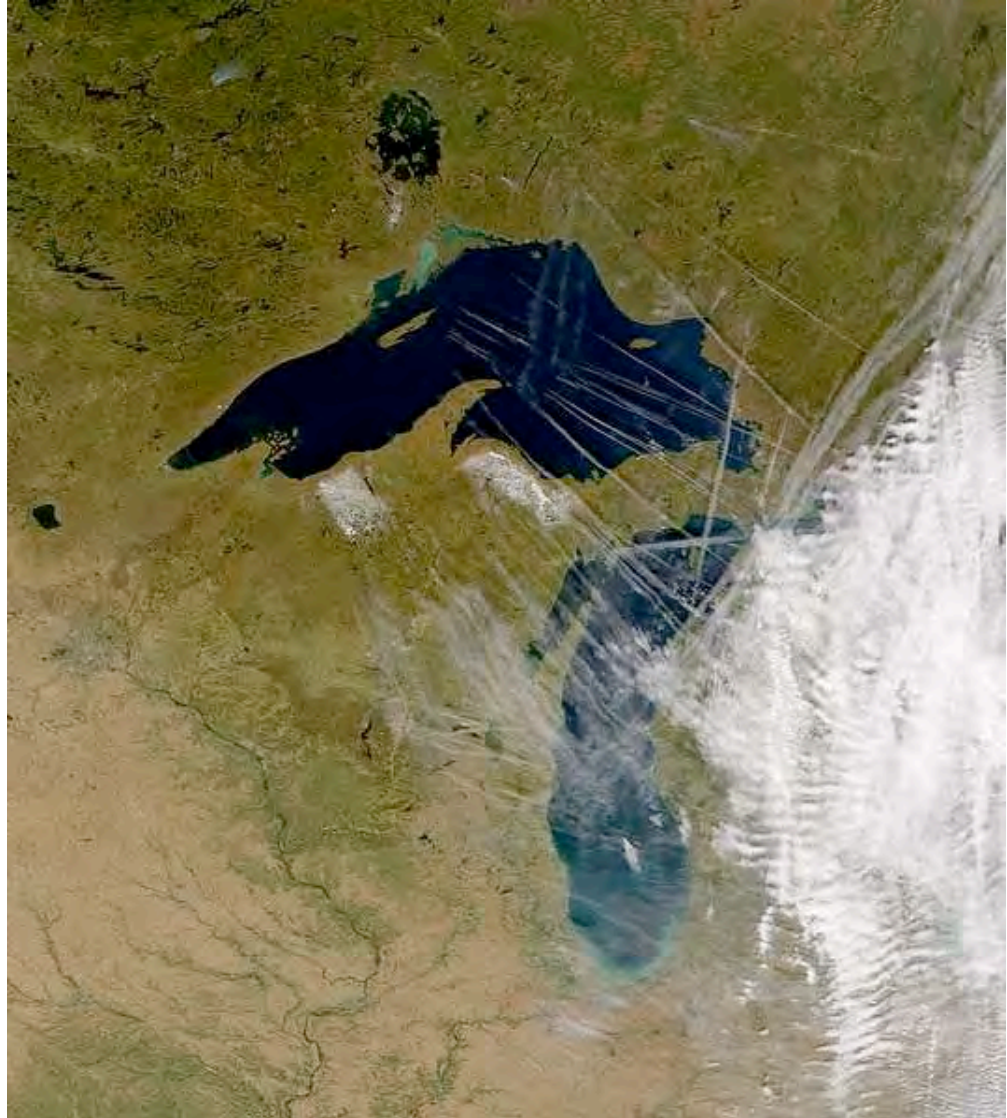
# Outline

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- Why is NASA involved?
- ***Why and how are students important to this study?***

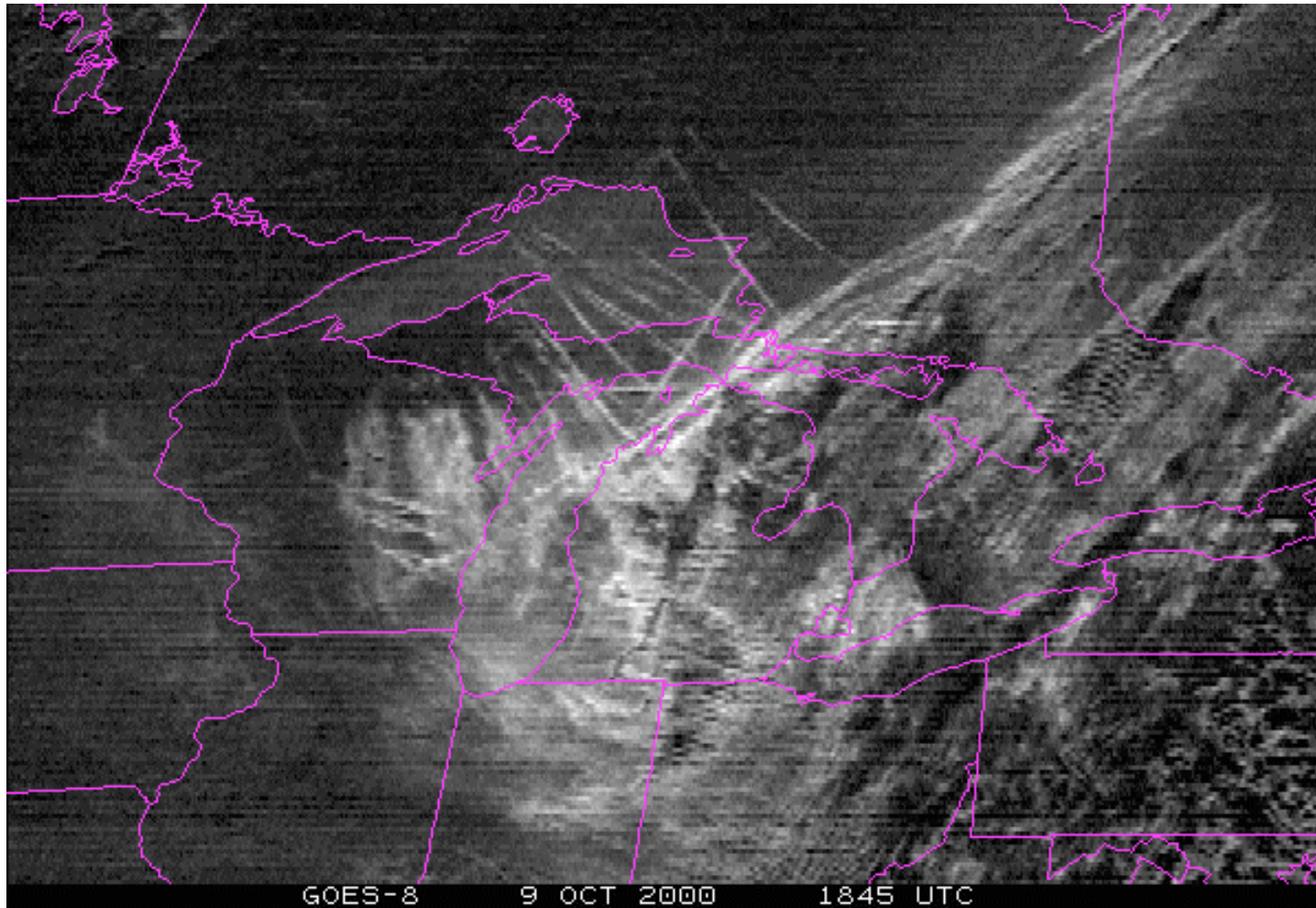
# Why can students help?

Our estimates of the climatic effects of persistent contrails are still uncertain.

We still have trouble estimating contrail coverage.



# Why can students help?



Most contrails are still smaller than the resolution of most satellites.



# Data Sheet

## Atmosphere Investigation Clouds 1-Measurement Data Sheet

School Name: \_\_\_\_\_

Observer names: \_\_\_\_\_

Date: Year \_\_\_\_\_ Month \_\_\_\_\_ Day \_\_\_\_\_ Study Site: ATM- \_\_\_\_\_

Local Time (hour:min): \_\_\_\_\_ Universal Time (hour:min): \_\_\_\_\_

### Cloud Type

**High (in the sky):**  
(Check all types seen)



☐ Cirrus



☐ Cirrocumulus



☐ Cirrostratus

**Middle (of the sky):**  
(Check all types seen)



☐ Altostratus



☐ Altimcumulus

**Low (in the sky):**  
(Check all types seen)



☐ Stratus



☐ Stratocumulus



☐ Cumulus

**Rain or Snow Producing  
Clouds:**  
(Check all types seen)

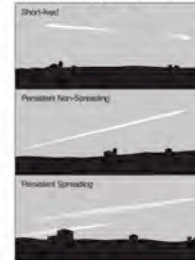


☐ Nimbostratus



☐ Cumulonimbus

### Contrail Type (Record the number of each type observed)



#### Short-lived Contrails

How many do you see? \_\_\_\_\_

#### Persistent Non-Spreading Contrails

How many do you see? \_\_\_\_\_

#### Persistent Spreading Contrails

How many do you see? \_\_\_\_\_

### Three-quarters or More of the Sky is Visible:

#### Cloud Cover (Check One)



**No Clouds**

☐ 0%-No Clouds



**Clear**

☐ <10% Clouds



**Isolated**

☐ 10-25% Clouds



**Scattered**

☐ 25-50% Clouds



**Broken**

☐ 50-90% Clouds



**Overcast**

☐ >90%

#### Contrail Cover (Check one)

☐ No Contrails (0%)

☐ 0-10%

☐ 10-25%

☐ 25-50%

☐ >50%

View of more than one-quarter or more of the sky is blocked: **Obscured** ☐ Check here

#### Why is the view of the sky blocked? (Check all that apply)



☐ Blowing Snow



☐ Heavy Snow



☐ Heavy Rain



☐ Fog



☐ Spray



☐ Volcanic Ash



☐ Smoke



☐ Dust



☐ Sand

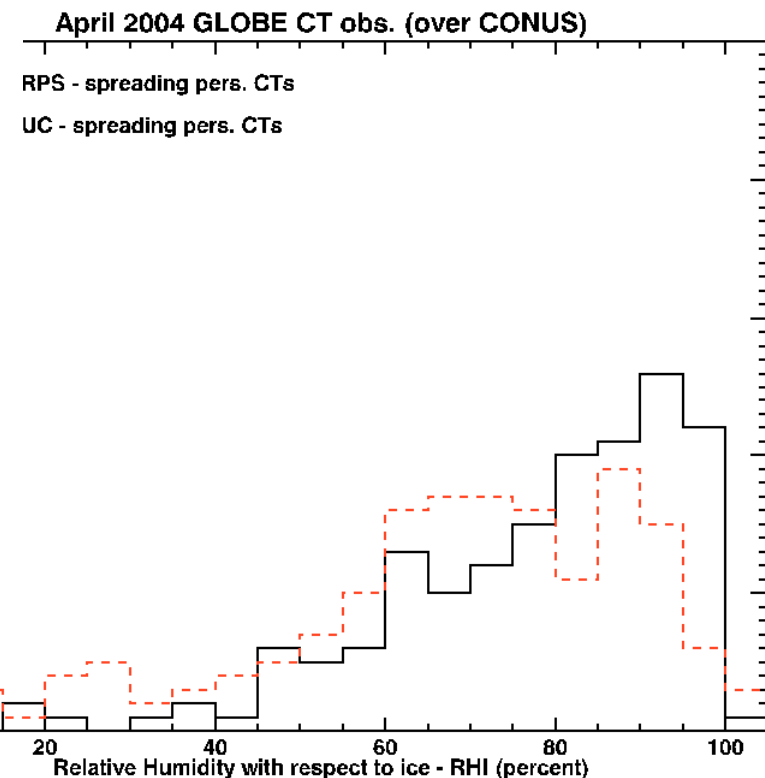
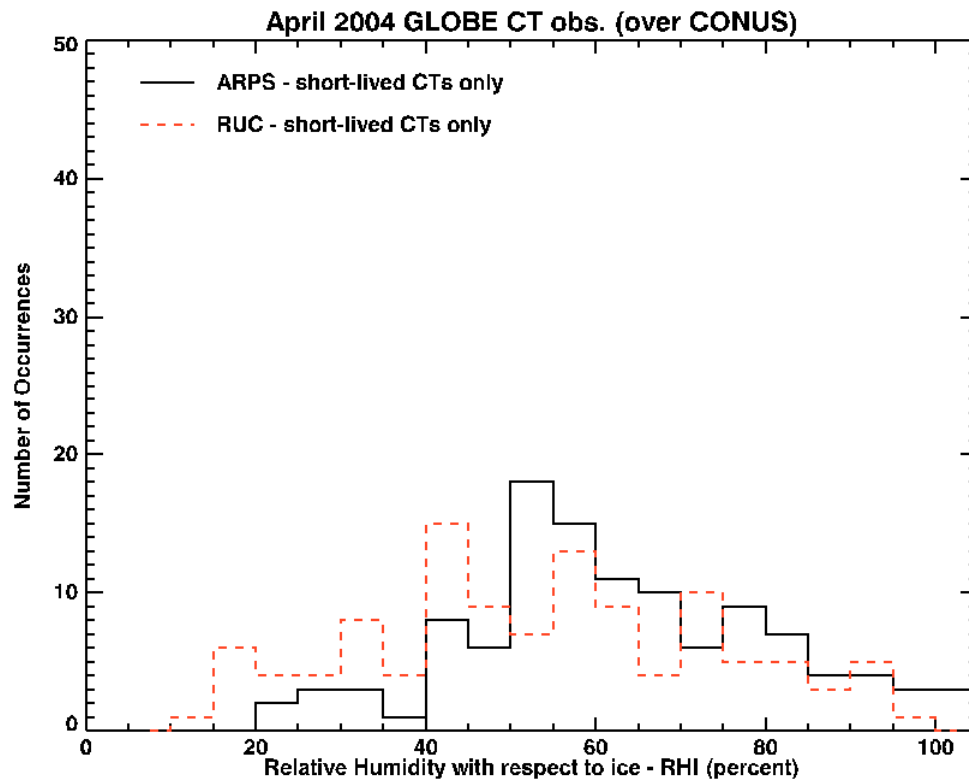


☐ Haze

Comments: \_\_\_\_\_

# Initial GLOBE Contrail Data Analysis

Dr. Dave Duda,  
Hampton University

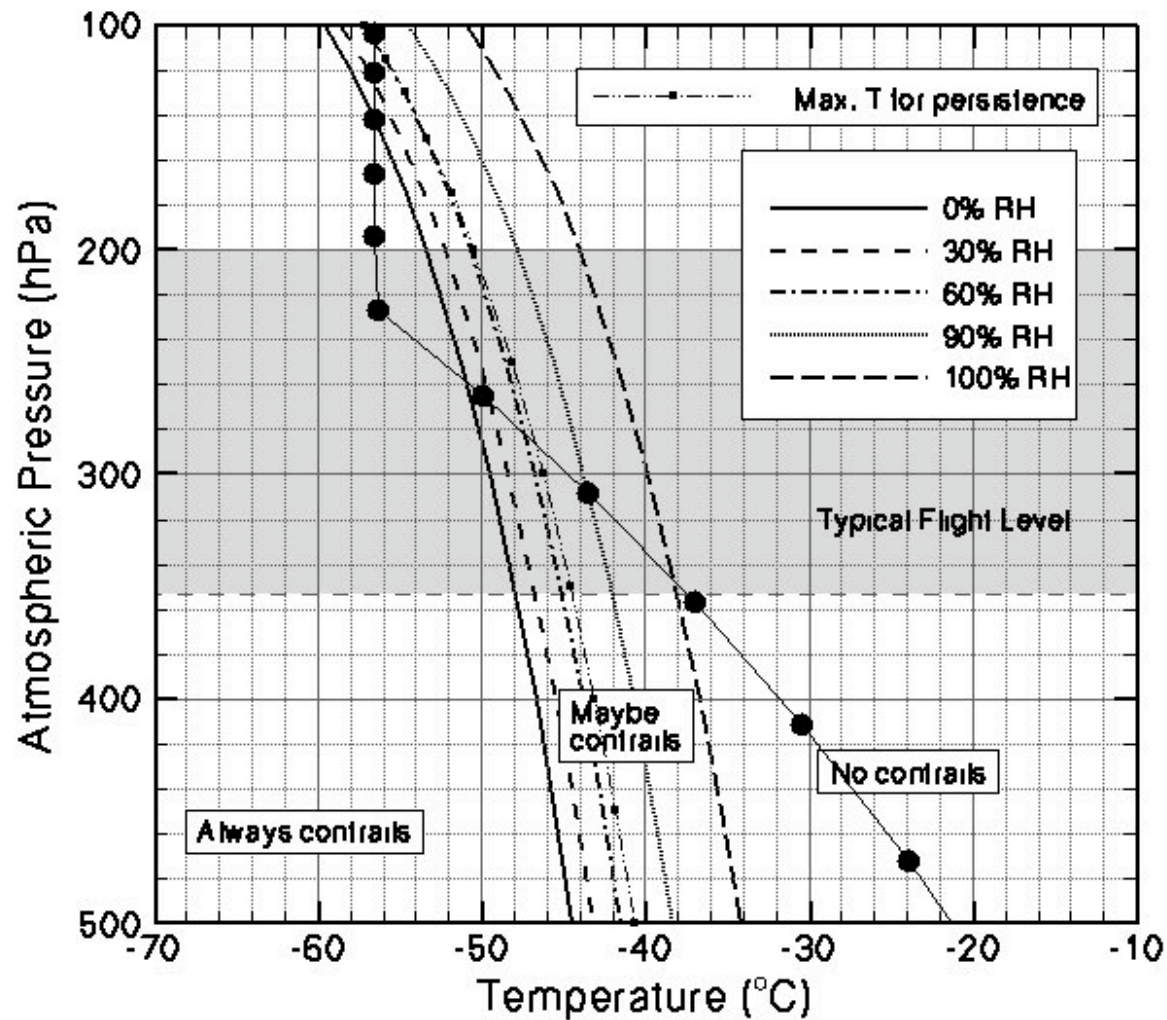


## Method


- Compare GLOBE obs to:
  - RUC (Rapid Update Cycle; Benjamin et al.)
  - ARPS (Advanced Regional Prediction System; Xue et al.)
- Initial comparison for April 2004
- 1500 GLOBE observations of contrails



# Website & Activities



<http://asd-www.larc.nasa.gov/GLOBE/>

- 
- Some other things you may see...

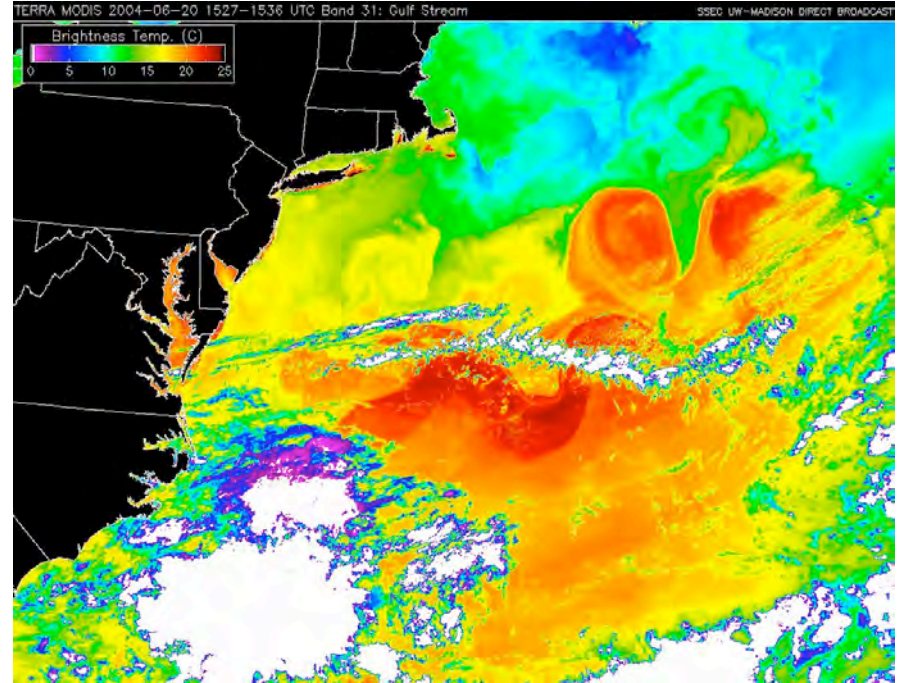
# Inverse contrails (distrails)



Aircraft sometimes make holes in clouds!



# Contrail Cousins



Cloud “zipper” on Father’s Day, 2004